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Development of a unit cost database to estimate costs for utility relocation projects

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Development of unit cost database to estimate costs for utility relocation projects

by

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Dedicated to my love, Sakshi

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Abstract

Development of unit cost database to estimate costs for utility relocation projects

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Utility relocation is a consequential step while undertaking a new transportation project. Past research shows that utility adjustment or relocation is one of the several major factors that causes delay in timely delivery of infrastructure projects, and cost overruns. Despite being recognized as an impeding factor to project delivery, there is no ready-to-use cost database or software platform available for estimating the relocation costs of different utilities. This thesis aims to collect, analyze and record historical cost data available through the executed utility agreements and develop a unit cost database which can be used in generating a cost estimate for a project. Since the data collected from agreements is limited by the availability of useful and relevant agreements gathered, data available from RS-Means and other publicly available databases is used to fill any gaps in cost data recorded, and further serve as a basis for validation of data collected from past agreements. As a product of this research, a database spreadsheet was developed which stores the data collected during the study and also allows for addition of new data by the user to further improve the database.

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Chapter 1 Introduction

RESEARCH MOTIVATION

Preparing a sound and reasonable cost estimate is a crucial step while kickstarting a project. It allows the project team to forecast cashflows during the year and secure funds accordingly. One of the pivotal tasks that defines the success of a highway project is the timely relocation of the utilities that are in conflict with the proposed highway design. Hence, it becomes eminent for the project teams to accurately estimate the utility relocation costs while laying down the budgeted estimate for the project. However, despite being a such a vital task for efficient project delivery, TxDOT Austin District utility team lacked a verified, reliable and comprehensive utility relocation unit cost database which could be used to create a preliminary estimate with of the costs to be incurred for relocating the conflicting utilities in the project. Such a database can also be used by the utility team to verify the cost details which are submitted by the utility companies along with the plans and specifications of relocation. The necessity of developing a pre-populated utility cost estimation database arises from the following main reasons –

- Lack of enough information about utility installations and utility adjustment needs for cost estimation during initial planning
- District utility coordinators estimate utility adjustment cost as inputs for preliminary design and construction cost estimates
- Utility adjustment costs tend to be underestimated for large projects
- Utility relocation costs carry high potential for risk and change and hence difficult to accurately estimate
- Utility adjustment costs are estimated at much higher level of aggregation compared to highway construction costs
- Inconsistency in dividing relocation cost between cost categories and work items

RESEARCH OBJECTIVES

Inaccurate cost estimates can lead to underestimating or overestimating the funds required to construct or relocate a facility, and thus can be impending to the smooth delivery of the project. Cost estimating process relies heavily upon accurate and up to date cost information. This information should be available in an organized and easy to use format for the estimator to use. However, since TxDOT Austin District is not directly involved in the construction process and thus not responsible for purchasing of material and hiring labor for doing the work, it does not have a ready to use database of historic unit costs for estimation purposes.

The main objective of the study was to develop an updated, verified and comprehensive database that lists unit cost rates for various types of utility relocations which could be used by the TxDOT project team to prepare preliminary budget level estimates for utility work in a highway project. The process included researching different available sources of cost information pertinent to utility relocation, followed by collection and analysis of the data, concurrently recording it in the database and finally verifying the results against the already available information.

RESEARCH SCOPE AND LIMITATIONS

Utilities analyzed in this study were classified into five broad categories namely Waterline, Wastewater line, Gas Pipeline, Electric Transmission and Communication Line. These major categories can be further sub classified based upon the size of the pipe, fiber or conduit. Also, the boring technique used in case of underground work affects the unit cost rate. Since the sources of useful and good quality data was limited, therefore including such a large number of utility items in the scope of work for this study was not possible. Hence, after several meetings and discussion with the TxDOT Austin District team, a scope list of utility types which were most frequently encountered in the projects handled by the team was filtered out. The scope for this study is discussed in more detail in Chapter 2.

READERS GUIDE

The thesis is organized into six chapters. Chapter 1 discusses the motivation, objective, scope, and organization of this thesis. Chapter 2 throws light on the methodology followed in this research for developing the unit cost database. Chapter 3 discusses the literature reviewed on subject matter pertinent to utility relocation, cost estimation of utility work, and standardization of construction specifications and cost estimation forms used during the process. Chapter 4 elaborates on the process of utility agreement data collection and analysis, and the challenges associated with it. Chapter 5 details the process of deriving unit costs using other sources of information, and its findings. Finally, Chapter 6 discusses the results, the structure of the database developed and recommendations for future work.

Chapter 2 Research Methodology

This research is divided into five major steps, as shown in Figure 2-1: (1) Conducting a literature review; (2) Defining the scope of work; (3) Utility Agreement Data – Collection and Analysis ; (4) Researching other means to derive Unit Cost Data; (5) Coalescing Unit Cost Data derived from different sources; (6) Results and Recommendations.

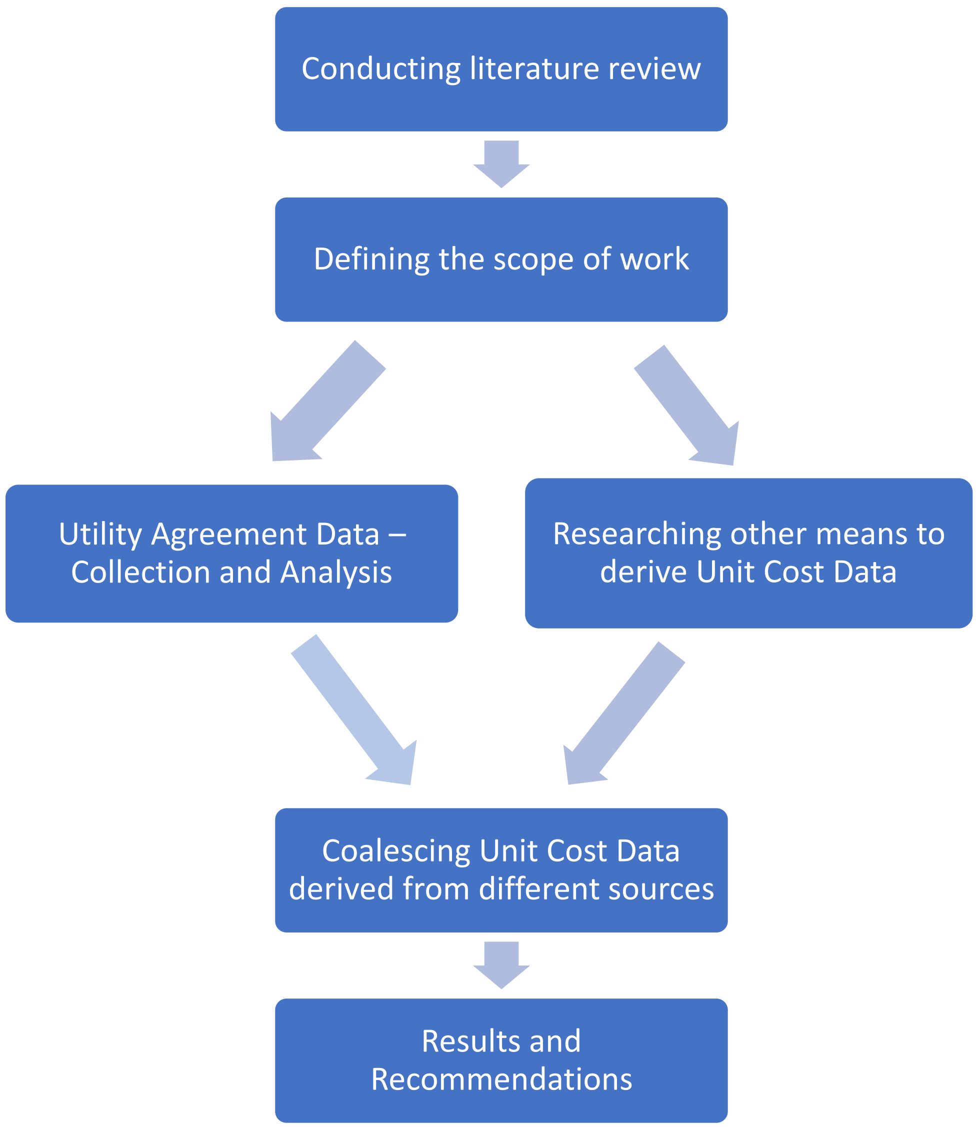

Figure 2-1Workflow diagram for Unit Cost Database Development

CONDUCTING LITERATURE REVIEW

The first step in the process was to accumulate and analyze the information currently available related to utility relocation and its cost estimation. Several journal papers, thesis study and technical reports were studied to develop an initial perspective about the process of utility adjustment and its monetary and delay impacts. This was helpful in getting familiarized with the terminology, the steps involved in relocation of a utility, and the different parties that are involved in the process. Literature dealing with utility adjustment costs and estimates focused mainly upon standardizing the forms and specifications used during the process and developing a framework for utility installation. Synopsis of the literature review is present in Chapter 3. Thorough review of the past works done in this field helped in constructing a research plan for collection of data and development of the unit cost database. This database would assist the TxDOT Austin District utility team to prepare an initial project estimate for budgeting purposes and would also act as a sanity check on costs submitted by the utility owners during the later stages of bidding and construction.

DEFINING THE SCOPE OF WORK

Before starting the construction of a highway project, the department of transportation ensures that relocation of all the different utilities that are in conflict with the planned design and construction is complete. Major utilities types can be covered under the following categories – Waterline, Wastewater Line, Gas Pipeline, Electric Distribution and Transmission, and Communication. However, there can be a lot of variation in the size and specifications of the pipes and conduits used in the process. Covering all of them in the database was infeasible and unnecessary. Hence defining a scope of work was crucial before starting the search for data sources. A comprehensive list containing all different size and specifications of utility was made available by TxDOT team. Following that, a meeting was held with TxDOT personnel to define the scope of utility sizes and specification to be included in the database. By filtering out those utility sizes and specification that were rarely used in projects undertaken by the Austin TxDOT team, the comprehensive list of utility types and sizes was narrowed down to 58 items that were to become the part of unit cost database. Table 2-1 shows the final scope of work included in the database.

Sr. No.	Facility Type	Size (In)	OH/UG	UG Technique
1	Gas	2	UG	Open Trenching
2	Gas	2	UG	Boring and Casing
3	Gas	4	UG	Open Trenching
4	Gas	4	UG	Boring and Casing
5	Gas	6	UG	Open Trenching
6	Gas	6	UG	Boring and Casing
7	Gas	8	UG	Open Trenching
8	Gas	8	UG	Boring and Casing
9	Gas	16	UG	Open Trenching
10	Gas	16	UG	Boring and Casing
11	Gas	24	UG	Open Trenching
12	Gas	24	UG	Boring and Casing
13	Waterline	4	UG	Open Trenching
14	Waterline	4	UG	Boring and Casing
15	Waterline	6	UG	Open Trenching
16	Waterline	6	UG	Boring and Casing
17	Waterline	8	UG	Open Trenching
18	Waterline	8	UG	Boring and Casing
19	Waterline	10	UG	Open Trenching
20	Waterline	10	UG	Boring and Casing
21	Waterline	12	UG	Open Trenching
22	Waterline	12	UG	Boring and Casing
23	Waterline	16	UG	Open Trenching
24	Waterline	16	UG	Boring and Casing

Table 2-1: Continued next page

Sr. No.	Facility Type	Size (In)	OH/UG	UG Technique
25	Waterline	24	UG	Open Trenching
26	Waterline	24	UG	Boring and Casing
27	Waterline	30	UG	Open Trenching
28	Waterline	30	UG	Boring and Casing
29	Waterline	36	UG	Open Trenching
30	Waterline	36	UG	Boring and Casing
31	Wastewater	4	UG	Open Trenching
32	Wastewater	4	UG	Boring and Casing
33	Wastewater	6	UG	Open Trenching
34	Wastewater	6	UG	Boring and Casing
35	Wastewater	8	UG	Open Trenching
36	Wastewater	8	UG	Boring and Casing
37	Wastewater	10	UG	Open Trenching
38	Wastewater	10	UG	Boring and Casing
39	Wastewater	12	UG	Open Trenching
40	Wastewater	12	UG	Boring and Casing
41	Wastewater	14	UG	Open Trenching
42	Wastewater	14	UG	Boring and Casing
43	Wastewater	16	UG	Open Trenching
44	Wastewater	16	UG	Boring and Casing
45	Wastewater	18	UG	Open Trenching
46	Wastewater	18	UG	Boring and Casing
47	Wastewater	24	UG	Open Trenching
48	Wastewater	24	UG	Boring and Casing
49	Wastewater	30	UG	Open Trenching
50	Wastewater	30	UG	Boring and Casing

Table 2-1: Continued next page

Sr. No.	Facility Type	Size (In)	OH/UG	UG Technique
51	Electric Distribution	N/A	OH	N/A
52	Electric Distribution	N/A	UG	Open Trenching
53	Electric Distribution	N/A	UG	Boring and Casing
54	Communication	N/A	OH	N/A
55	Communication	Small	UG	Open Trenching
56	Communication	Small	UG	Boring and Casing
57	Communication	Large	UG	Open Trenching
58	Communication	Large	UG	Boring and Casing

Table 2-1 Scope of utility types to be covered

COLLECTING AND ANALYZING UTILITY AGREEMENT DATA

After gaining a preliminary insight on the utility relocation process through literature review and defined scope of work, the next step was to look for sources that contained cost data pertinent to utility relocation. After discussion with the TxDOT utility team, it became known that one of the most relevant and reliable sources for finding cost related information about utility relocation are the past utility agreements executed between TxDOT and the utility companies. Utility agreement is a form of contract signed between the Utility Company and TxDOT, which comprises of all the details relevant to the relocation process including plans and specifications, signed agreement letter and other correspondences. The agreement also includes the construction cost estimates, information about the eligibility for reimbursement and a preliminary schedule for the job. Due to unavailability of digital copy of this data, physical visits to data archives were made to analyze and collect useful information from these agreements. More details on the utility agreement and the data collection process are elaborated in Chapter – 4.

RESEARCHING OTHER SOURCES FOR UNIT COST DATA

Looking at multiple sources of information is always considered a good practice in research studies. So, to supplement the cost data collected from utility agreements, other publicly available sources of utility cost data were researched. These included RS-Means

Online database, City of Austin database and TxDOT historic cost data base. Local subcontracting companies, suppliers and vendors were also reached out to gather a wide range of cost information. However, since cost information is confidential and a competitive advantage for these firms, most of them showed reluctance to share cost related information.

Collecting data from different sources provided a means for comparison and also a way to fill up the gaps in unit cost database created due to limited availability of good quality utility agreements. Most of the data in these sources was available with activity level or material level detail. Therefore, a spreadsheet was created to combine all the data elements pertinent to a particular utility relocation and arrive at a total cost. Assumptions were made during this process and different analysis were performed to arrive at some components of costs, both of which are discussed in more detail in Chapter – 5.

CREATING A UNIT COST DATABASE

The final step in creating the cost database was to combine the unit cost rates derived through different sources of data. A spreadsheet was created which listed all the utility types in the scope of the research, and corresponding cost information found was populated for each of them. Some of the utilities types, which were more frequently encountered in the projects had more than one cost data, which provided a range in which the per unit cost of relocation can lie. For some utility types, there was just one cost data found through the available utility agreements. The cost database created can be easily updated as more cost information through agreements or other sources becomes available.

Chapter 3 Literature Review

This chapter discusses the overview of the utility relocation process and the impacts utility relocation has on highway projects. The financial and time aspects associated with the adjustment process are also discussed. The chapter also throws light on the cost estimation process for utility relocations and types of estimates used for budgeting these costs. A review of research conducted on standardizing the utility construction specifications and cost estimation forms is also provided.

UTILITY RELOCATION PROCESS

Recent studies point that utility relocation and conflicts and are among the top contributors to highway construction delays. (R. D. Ellis 2002). A FHWA study indicated that 31 to 55 percent of the highway projects exceed their original contract duration. (FHWA 1985). To understand the details related to the utility relocation process, the first step is to understand the need to adjust utilities. Legally, utilities have the statutory right to occupy the Right of Way (ROW). “These rights are extended, provided the utility use will not interfere with safety of the traveling public, the State’s ability to construct and maintain the highways, and as long as they maintain compliance with the UAR” (Texas Department Of Transportation 2014). The conflict arises when the state Department of Transportation and the utility providers compete for limited space within the ROW. The first approach always is to resolve such a conflict through changes in design of the proposed highway. But if that does not resolves the conflict, then the utility company has to relocate their facility to provide the ROW to the state. This process is known as utility relocation or adjustment. A successful utility relocation process relies heavily on constant communication and coordination between the DOT and utility companies. (Shetty 2015). Timely adjustment of conflicted utilities in the ROW is crucial to successful delivery of a highway project. The delays in utility relocation process can set off a domino effect, which can also delay the actual construction progress and thus result in change orders and damage or litigation claims, safety concerns at the job site, annoyance, and poor public perception of the project (Quiroga, et al. 2012).

In TxDOT, the utility relocation process usually starts with the district office informing the utility coordinator about the proposed project plans. The utility coordinator is then tasked with identifying the utilities in vicinity of the proposed project and establishing contact with their owners. Once the source of funding (federal or state) and the status of ROW acquisition is known, a meeting between TxDOT and utility companies is organized to determine which utilities conflict with the proposed project design. A unique U/P number is assigned by TxDOT to each utility on the project which helps in tracking and recording their status and other information. TxDOT provides a schematic design to the utility providers so that their design team can perform a conflict analysis and determine if their utility will conflict with the project. With concrete information about the utilities conflicting with the project design, the utility coordinators move ahead with developing a utility adjustment plan.

Generally, utility owners are accountable for moving their facilities, including budgeting, locating existing lines, preparing plans, specifications and estimates, and letting contracts (Texas Department Of Transportation 2013). This process starts with TxDOT organizing a kick-off meeting with all conflicting utility companies, wherein they are provided 30% complete design of the roadway, so that they can come up with their relocation plan and schedules for utility adjustment. The next step in the process is to provide the utility companies with agreement assembly forms and access to Utility Accommodation Rules (UAR) along with 60% complete roadway design plans, which allows the utility companies to finalize their design, cost estimates and schedule. Once these documents are submitted to the TxDOT utility coordinators, they review it and if they are not satisfied they can request the utility companies to make the necessary changes and resubmit. If the submissions are acceptable, TxDOT moves forward with executing the final agreement and issuing notice to proceed to start the relocation.

During the actual relocation phase, the progress of work is overlooked by TxDOT and project managers. The project manager decides if the work performed by the utilities is as per agreement. If it is deemed acceptable, utility company is asked for as-built and final billing; in case the work performed is not per agreement utility is required to perform re-work as per

TxDOT satisfaction. Submission of the as-built plans by the utility company to TxDOT, marks the end of utility adjustment process (Bhambotta 2016).

FINANCIAL AND TIME ASPECT OF UTILITY RELOCATION

Financing the utility relocation is an important aspect which depends on different factors. As per the project development process manual, typically utility owners are responsible for relocating their facilities, which also involves planning, budgeting and letting the contract for relocation (Texas Department Of Transportation 2013). This case of relocation project is termed as a “Non-Reimbursable Project”. However, in some cases the TxDOT will pay for the adjustment and this kind of project will be termed as a “Reimbursable Project”. A utility adjustment can be classified as “Reimbursable Project” if (1) Highway project has federal funds; (2) Utility owner has compensable property interests. In the event of a federally funded project, both utilities with and without compensable property interest are eligible for cost participation by the state DOT according to Part 645 of the 23 Code of Federal Regulations (23 CFR) (Code of Federal Regulations 1999). If the owner claims a compensable interest in the property, TxDOT pays for the new easements and the cost of adjusting the utility. Utility relocation process can also be partially reimbursable. In such a case the eligibility ratio is used to determine the amount to be reimbursed to the utility company. The eligibility ratio is a part of the utility agreement signed between the two parties (O'Connor, et al. 2006).

Timely relocation of these utilities is another matter of concern for the TxDOT Utility Coordinators as it has been established that utility relocation delays are primary contributors towards highway construction delays (Arboleda, et al. 2004). Impediments in relocation of utilities can also hamper the actual construction progress of highway. Thus efficient planning and execution of utility relocation is of vital importance for timely project delivery. Delays in the completion of highway projects result in inconvenience and safety risks to the public as well as the higher cost to state DOTs (Chou 2007). Schedule delays can also cause cost overruns in these highway projects. In some cases, the DOTs provide compensation in the form of time extensions or paying extended general conditions to the contractor. But usually the contractors account for utility adjustment delays by inflating the bid price according to the assessed level of risk.

COST ESTIMATION FOR UTILITY RELOCATION

Utility reports which are prepared during the scoping phase of the project, are required to have estimated cost impact of different utility relocation alternatives and any reimbursable costs associated with it. The reimbursable cost estimates developed for the Utility Report are a preliminary estimate of costs that can be used as the initial Utility Reimbursement (UR) budget for the project (ODOT 2015). To prepare these budgets, and estimate the reimbursable costs, the DOTs require a database of unit cost per feet of utility relocation, to arrive at total cost of relocating all the different utilities on a project. Also, the utility companies are responsible for submitting a detailed cost estimate for the different items of work in their proposal. In order to evaluate these proposals and check the reasonableness of the estimates, the DOTs need the database for comparing the unit costs for work items used in these estimates. Over the past years, many DOTs have experienced variations in estimated costs compared to invoices for the relocation of utilities on projects for which the utility company has prior rights and the DOT is responsible for reimbursing the utility company. On reimbursable utility relocation projects, utility companies and State DOTs are required by law to enter into agreements describing the scope of work and responsibilities for financing and accomplishing the work. Cost estimates identify the items of work to be performed, broken down by the estimated costs of direct labor and surcharges, overhead and indirect construction charges, materials and supplies, handling charges, transportation, equipment, contingencies, right-of-way, preliminary engineering, construction engineering, salvage credits, betterment credits, accrued depreciation credits, etc., and are an essential part of these agreements. The estimates for these items of work should be detailed to such an extent that the state DOT can perform the task of cost analysis and budgeting, as well as verify the reasonableness of invoices (Reinke 2010).

TYPES OF UTILITY COST ESTIMATES

The type of cost estimate depends upon the amount of information available to the estimator while putting towards an estimate. According to a presentation report prepared by INDOT, the following types of estimates are used to calculate utility estimation costs-

1. **Parametric Estimate** – This estimate is put together in the initial stages of project development. It provides a rough amount of money to be used in relocating the utilities with respect to the total cost of the project. It does not takes into account the site/utility conditions. It is to the discretion of project manager to accept or decline these recommendations. An example of parametric estimate is shown in Fig. 3-1

	Non-Interstate	Interstate
Rural	5%	10%
Urban	10%	15%

- Example:
  - SR 256 in Austin
  - Estimated Project Cost: $315,000
  - Utility Estimate: $31,500

Figure 3-1 An example of parametric estimate (Source - INDOT presentation report on Agreements and Cost Estimates)

2. **Ballpark Estimate** – This is a more refined estimate of the utility relocation costs on the project and is also specific to the project. It can be submitted by the utility company with their initial response notice or prepared by the DOTs to estimate the funds that might be needed to complete the project. It is based on initial anticipated accommodation required and develops through the course of the project as more information becomes available. It can be as simple as cost per foot estimate in which the length in feet of the utility line (Gas, Water, Wastewater, communication or electric) is known and that is multiplied by the cost incurred per foot to relocate it.

3. **Detailed Estimate -** A detailed estimate consist of the total relocation cost broken down into different cost components including – material, labor, equipment, transportation, overheads such as engineering, management, design, supervision etc. It has the same structure as the final invoice that is submitted by the utility company after completion of the job. It might be a result of multiple refinements throughout the course of project development. A sample detailed estimate is shown in Fig. 3-2

Betterment-Included Estimate

Alpha Construction Co.		
6,000 feet of 12-inch Water Main	$335,000	
6,000 feet of 6-inch Sewer Main	$66,700	
Forced Betterment	$16,300	
Beta Inc. Engineering Total Fee	$15,000	
Gamma Surveying Ltd. Fee	$2,500	
Easement Acquisition Cost	$4,500	$440,000

In-Kind Replacement Estimate

Alpha Construction Co.		
6,000 feet of 4-inch Water Main	$207,000	
6,000 feet of 6-inch Sewer Main	$66,700	
Forced Betterment	$16,300	
Beta Inc. Engineering Total Fee	$11,000	
Gamma Surveying Ltd. Fee	$2,500	
Easement Acquisition Cost	$4,500	$308,000

Betterment Amount		$132,000
Betterment Ratio:	$132,000/$440,000 = 0.3000	
Accrued Depreciation Credit	$0	
Salvage Credit	$0	

Current Installation ROW Summary:

Sheet No.	State ROW	Private ROW	Unit
D-1	200	1,300	feet
D-2	100	1,000	feet
D-3	400	1,100	feet
D-4	500	1,400	feet
Total	**1,200**	**4,800**	**feet**

Total ROW:	6,000 feet	
Eligibility Ratio:	$4{,}800/6{,}000 = 0.8000$	
Amount eligible for state cost participation:	$\$308{,}000 \times 0.8000$	$246,400

Figure 3-2 A sample of detailed cost estimate. Source (Quiroga 2007)

STANDARDIZATION OF COST ESTIMATION FORMS

In the recent years, a large variation has been observed in the estimated costs submitted by utility companies for relocating their facility. This inconsistency has motivated research towards standardizing the construction specifications for utility relocations and cost estimation forms submitted by the utility companies, so the utility coordinators can compare and analyze the reasonableness of the estimate. A considerable amount of work in this field has been conducted at the Texas Transportation Institute (TTI) at Texas A&M University with support from Texas Department of Transportation (TxDOT). Under the report titled "A Specification Framework for Communication Utilities and Estimation of Utility Adjustment Costs" (Quiroga 2007) the author has summarized a methodology to develop utility adjustment cost estimates during the early stages of the project development process and a procedure for estimating the uncertainty and likelihood of exceeding those estimates. A specification has been proposed relating to the adjusting, removing, and relocating of pole assemblies. The specification breaks down different work activities into separate line items, making it easier to assemble an accurate cost estimate. The report also lists several reasons for improving the capability to forecast utility adjustment costs, including the construction costs that are frequently underestimated.

In another report published by TTI titled "A Unit Cost and Construction Specification Framework for Utility Installation" the author focuses on the lack of a standardized and comprehensive set of specifications for contractor use (Quiroga 2006). In Texas many different versions of special specifications and provisions exist throughout the state. Quiroga proposes a standardized methodology and procedure to help determine actual costs involved in a utility relocation. The author mentions that in addition to the need to standardize construction specifications for utility installations is the need to standardize methodologies and procedures for the determination of utility relocation costs. The standardized cost estimate form should be simple, easy to use, and flexible for use on all types of utility relocation projects (Reinke 2010). According to the TxDOT Utility Manual, utility relocation cost estimates need to identify the items of work to be performed, as broken down into categories such as materials, labor, overhead, transportation and equipment, traffic control, betterments, and miscellaneous (TxDOT 2015). In practice, there is a wide range of ways in which utility companies submit utility relocation costs for reimbursement. In addition, this cost structure is not backed by a corresponding set of specifications that could facilitate inspections in the field. The lack of standardization translates into difficulties in verifying the validity of the cost data submitted for reimbursement and how to adequately prepare for audits. The report also highlights different issues associated with cost reporting in the estimates submitted by the companies. These include a different level of aggregation of cost category data between the final bill and the supporting work order documentation. great variability in accounting detail and missing unit cost information to support the total cost. The report emphasizes on the applicability of unit cost approach for utility relocation work. Some degree of unit cost within an estimate is not only unavoidable, but also usually desirable because it defines line items to be addressed during reimbursement. Although the report focuses primarily on water and sanitary sewer specifications, the methodologies discussed can be applied to all areas of utility relocation.

Chapter 4 Utility Agreement Data – Collection and Analysis

After gaining a preliminary insight on the utility relocation process through literature review and defining the scope of work, the next step was to look for sources that contained cost data pertinent to utility relocation. After discussion with the TxDOT utility team, it became known that one of the most relevant and reliable sources for finding cost related information about utility relocation are the past utility agreements which were executed between TxDOT and the utility companies. Physical copies of these agreements have been archived at TxDOT offices. Since the research was based in Austin, the offices of TxDOT in Austin were chosen to collect utility agreement data.

PLAN FOR COLLECTION OF UTILITY AGREEMENT DATA

TxDOT has two offices in Austin, one is the ROW Division which coordinates the acquisition of land to construct highways for all the projects under TxDOT and the other is the Austin District Headquarters that manages the transportation system of 11 counties, including Travis, Williamson and Hays that covers the Austin district. Both office locations have archive storage areas, where utility agreements executed between TxDOT and utility companies in the past are stored. However most of those agreements are not available in the form of a digital file that can be shared electronically for research purposes. This created a need to physically visit these offices by scheduling an appointment with TxDOT staff and going through the archives under the supervision of the TxDOT personnel to filter out the agreements relevant to the study.. Filtering was required because these archives also store Land Acquisition Documents, Addendums to Agreements, and Joint Use Agreements, which were not pertinent to the research as they did not contain cost related information. A total of 8 visits were scheduled over a period of 8 months to collect agreement data from different TxDOT offices. Table 4-1 provides the details of visit and the number of agreements collected in each visit.

Date of Visit	Office Division	Total Agreements	Waterline and	Gas Pipeline	Electric Distrib	Commu nication
9/9/16	Austin District	20	4	3	3	10
9/30/16	ROW Division	7	3	2	1	1
11/4/16	ROW Division	13	2	5	3	3
12/9/16	ROW Division	5	0	3	2	0
1/20/17	ROW Division	6	0	1	3	2
3/24/17	Austin District	14	4	1	5	4
4/07/17	Austin District	25	7	4	6	8
4/28/17	Austin District	11	3	0	1	5
Total		**81**	**19**	**16**	**21**	**23**

Table 4-1 Details of Visit to TxDOT office and Agreements Collected

After filtering out the relevant agreement data, files were scanned and stored on a university database for later review and analysis. Due to manual nature of the task, a considerable amount of legwork was involved in collection and storage of data. Also, scheduling the visit to these offices required efficient time management, proper permitting and access, and coordinating availability, which constrained the number of visits per month.

COMPONENTS OF A UTILITY AGREEMENT

In order to understand the process of deriving unit costs from the utility agreements one needs to be familiar with the different parts of a utility agreement. A Utility Agreement is an official binding contract between two parties, in most cases, the “State” and the “Utility”. The agreement obligates the “Utility” to adjust, remove or relocate certain facilities as defined under the statement of the work in the agreement. Whereas the “State” is obligated to participate in the costs for adjustment, removal or relocation of such facilities to the extent as deemed eligible for State or Federal Participation. Some of the elements of the agreement that are consistent in most of the agreements collected, and are relevant to the study, are discussed below –

(1) Utility Number – Utility Number or “U” numbers are unique numbers that are assigned to each utility by the division that is identified on the project. All standard utility agreements are identified using this “U” Number. It usually mentioned on the first page of the agreement along with other project specific information. Fig 4-1 shows a sample of project information sheet including the “U” Number assigned to the project.

(2) Project Specific Information – Every standard Utility Agreement also contains project specific information including but not limited to, District name, County name, Federal Project Number, Highway Number, ROW CSJ Number, Project Limits and Project Letting Date. This information also helps in identifying a utility relocation project in case “U” number is unassigned or missing. It also provides some important information about the project which was helpful while deriving unit cost for relocation of the utility. Fig 4-1 shows a sample of project information sheet.

Form ROW-U-35
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Page 1

STANDARD UTILITY AGREEMENT

U-Number: **U1456**[redacted]

District: AUSTIN[redacted]
Federal Project No.: 0353(2[redacted]
ROW CSJ: 0015-08-[redacted]
Highway Project Letting Date: 05/201[redacted]

County: WILLIAM[redacted]
Highway: 35 [redacted]
From: BUD S[redacted]
To: 2000' SO[redacted]

Figure 4-1 Sample Project Information sheet of Standard Utility Agreement

(3) Statement of Work – Most but not all agreements consist of a defined statement of work which describes the relocation work to be performed by the utility company as a binding under the agreement. This information is very crucial while deriving the unit costs from an agreement as it articulately explains the reader, the type of work being performed and sometimes also quantifies the work being done in terms of linear feet of pipe or conduit being relocated. Fig 4-2 shows a sample statement of work defining the length of waterline and wastewater line to be relocated.

> **WHEREAS,** the proposed highway improvements will necessitate the adjustment, removal, and/or relocation of certain facilities of **Utility** as indicated in the following statement of work: [Abandon and replace approximately 570 feet of 2 inch copper water line, 3,344 feet of 12 inch DI water line, and 4,485 feet of 18 inch PVC force main water line with approximately 15 feet of 2 inch PVC water line, 4,001 feet of 12 inch DI water line, 139 feet of 16 inch DI water line, and 4,723 feet of 24 inch PVC force and assorted appurtenances] ; and more specifically shown in **Utility's** plans, specifications and estimated costs, which are attached hereto as Attachment "A".

Figure 4-2 Sample statement of work

(4) Estimated Costs – The estimated costs for the relocation are included in the agreement as an attachment. These estimates are submitted by the utility companies based on the project plans and specifications, before the starting of the work. The payment for work is based upon the actual work done during construction. The actual invoice for the work done is also attached to the agreement once the work is completed. Figure 4-3 shows a sample of estimated costs included in a waterline relocation agreement.

ITEM NO.	PAY ITEM	DESCRIPTION	UNITS	Total	UNIT COST	TOTAL COST
1		TRENCH EXCAVATION PROTECTION	LF			
2		WET CONNECTION 2 DIA X 2 DIA	EA			
3		PIPE (2") DR 11 HPDE WW MAIN (ALL DEPTHS)	LF			
4		PIPE (1.25") DR 11 HPDE WW SERVICE (ALL DEPTHS)	LF			
5		VALVE (2") WW ISOLATION	EA			
6		VALVE (2") WW FORCE MAIN FLUSH ASSEMBLY	EA			
7		WW SERVICE (1.25") BALL VALVE AND BOX	EA			
		Contingency (10% of Subtotal)				
ESTIMATED CONSTRUCTION COST						

Figure 4-3 Sample of waterline cost estimate part of an agreement

(5) Plans and Specifications. Plans and Specifications of the utility relocation project are also included in the utility agreement package. These include information regarding the type of work, the length of the project and the specification of material being used, which is crucial while determining the unit cost.

There are several other elements of a standard utility agreement package, such as Utility's Accounting Method, Utility's Schedule of Work, Eligibility Ratio Sheet, Betterment Calculations etc. However, these are not relevant while deriving the unit cost of utility relocation. Hence, these are not explained in this report.

DERIVING UNIT COST FROM UTILITY AGREEMENT DATA

The principle behind deriving unit cost data from a utility agreement is very straight and simple. The total cost provided in the agreement is divided by the total linear feet of work. This is the cost to perform relocation of utility per feet. However, the complexity and uniqueness of each agreement makes the work challenging and time consuming. These challenges are discussed in more detail later in this chapter.

The total project cost is usually contained in the Estimated Cost section of the utility agreement. The estimate may or may not explicitly state the inclusion of indirect costs such as overheads, engineering costs, mobilization costs etc. Some utility companies include theses costs as part of their direct costs. Hence, it was assumed that the project cost mentioned in the agreement was inclusive of all the expenses required to perform the relocation.

Finding the total linear feet of work was more challenging as compared to extracting the total project costs. Some agreements had the total linear feet of work explicitly stated in the Statement of Work or Estimated Costs, making the process of unit cost derivation fairly easy. However, for most of the agreements, plans and specifications were referred to extract the total linear feet of work. Some of the challenges associated with it are discussed in the next section.

In certain cases, help of online global positioning system (GPS) was taken to determine the length of the project. The location of the project was identified and positioned on the GPS, and then by referencing the drawings, the route of the project was tracked and total linear length of the project was derived using the measure distance tool available in system. Figure 4-4 depicts the process of finding project length using google maps.

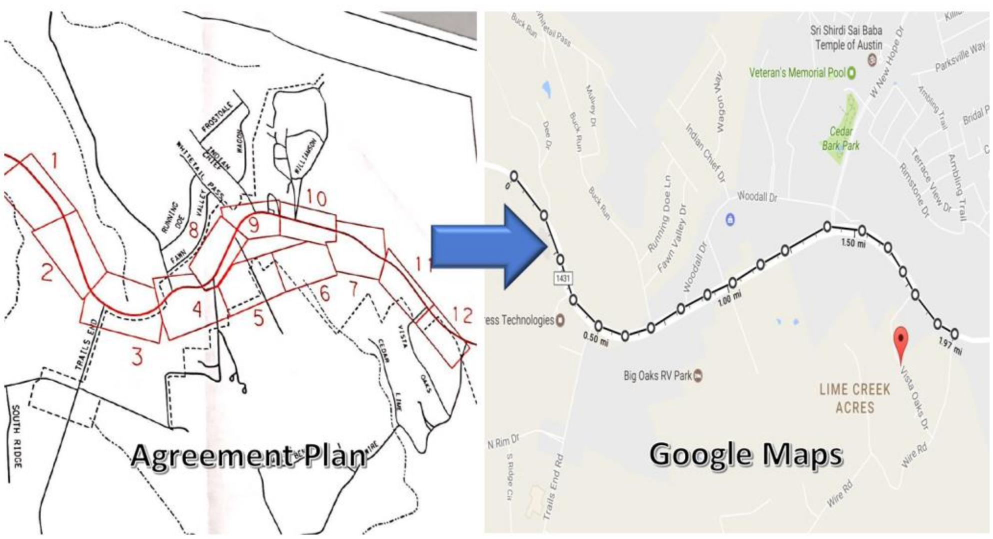

Figure 4-4 Tracking length of Electric Distribution Line on online GPS (Google Maps)

CHALLENGES IN UTILITY AGREEMENT DATA COLLECTION

This section expounds the challenges that were faced and overcome during the process of utility agreement data collection and review. As described earlier that even though the fundamental behind deriving unit cost from the utility agreement is simple and straightforward, but the lack of standardization of the cost estimate data in the agreement, made the process demanding and challenging. There are several other factors that make the process onerous and cumbersome. A detailed overview of these challenges is presented in the following points –

(1) Varying scope of work – Every agreement corresponds to a particular utility relocation project. And every project is unique in terms of location, scope of work, utility company performing the work, and the means and methods used to do the job. This exclusiveness makes the process of categorizing the agreements based upon their specifications a tough job. Some agreements were disregarded as it was difficult to categorize them into any particular category because of their extensive or exclusive scope and means of work. For some agreements modifications were made to the agreement costs to standardize the scope of work. For instance, Agreement No. 11075 consisted of relocation of 6" Gas Pipeline. The stretch consisted of both open trenching placement and boring and casing work. The costs for these two types of relocations were not segregated in the cost estimate. Since the cost for relocating a 6" pipe using boring and casing were already known, therefore cost of relocation of 6" gas pipeline through open trenching was determined by reducing the costs for relocation done using boring and casing.

(2) Lack of standardized cost estimation framework- The importance of standardizing the cost estimation framework has been emphasized by numerous studies in the past. However still most of the agreements lack a standardized way to input costs in the estimate sheets submitted by the utility companies while quoting for the job. Each utility company has their own method of estimating and reporting the costs. For instance, some companies include the engineering, project management and other indirect costs within the costs, while some estimate them as a separate cost item. Such

inconsistencies make it difficult to analyze and categorize the agreements. This challenge was overcome by making a reasonable assumption that the total cost listed in an agreement was the final amount required to perform that relocation.

(3) Complex Agreements- The complexity of an agreement can be defined by the intricacy and the extensiveness of work covered in that agreement. Usually the high dollar value agreements are difficult to analyze, and deriving unit cost of work from them can be challenging. This is because the scope of work is large, containing more than one utility types being relocated under a single agreement. And mostly in such agreements, the costs amounting for each type of utility relocation is not segregated. Thus making it unfeasible to derive the unit costs for each particular utility. For instance, Agreement No. 14117 constituted of relocation of 7 different types of water pipelines including 2" copper, 12" Ductile Iron, 18" PVC, 2" PVC, 16" Ductile Iron & 24" PVC.

(4) Scheduling a visit – The process of utility agreement data collection was also restrained by some physical limiting factors. As described earlier in this report that the past utility agreements are stored at the offices of TxDOT in form of printed hard copies. To access those agreements and collect data from them, an appointment was required to be scheduled with TxDOT to visit the office and collect the required data. Due to confidentiality of the agreements and the data contained in them, the visit was supervised by a TxDOT staff member. This required fine coordination and efficient time management to make the most out of the time spent while going through those agreements. This arrangement also restricted the number of visits to the office that could be planned in a month. An effort was made to plan at least one visit in a month, with a maximum frequency of 3 visits in a span of 35 days.

(5) Limited useful Agreements – Out of the numerous utility agreements reviewed, 81 were scanned and collected for further analysis for deriving unit costs. Out of those 81 agreements, 27 were finally used to produce unit cost results which were included in the final database. Some of the agreements were used to provide supplemental information such as pipe costs, or boring and casing costs, or helped in developing an

understanding about the relocation work and the cost components included. But many of the agreements collected had to be disregarded because of reasons including extensive and complex work scope, unidentifiable project length, illegible plans, unsegregated project cost based on utility type, missing cost estimate or plans, etc. Thus, the probability of finding a useful agreement is about 30 percent. Also, while going through the agreements at TxDOT office, many records which were found were joint use agreements or addendums, which mostly don't contain cost information regarding the utility relocation, hence of limited use for this study.

Chapter 5 Other sources of unit cost data

Considering the low rate of success in attaining data using the means of agreement analysis, the focus of the research was shifted towards finding other sources of cost data. The main objective of finding these sources was to fill the gaps in the unit cost database. These gaps were a result of limited availability of useful utility agreement data. For Gas line, Waterline and Wastewater line utilities, very few useful agreements were found and the database lacked cost data for most of the different sizes of gas line, waterline and wastewater line. To fill these gaps and populate data for these utility types, many online and physical sources were researched. A list of some of the major sources looked at is shown in Table 5-1.

Sr. No.	Source	Description
1.	RS-Means	RS Means is a cost database that stores and updates costs for different construction activities and materials.
2.	City of Austin Average Bid Prices	It is a publicly available database that stores construction costs from the past projects under taken by the City of Austin.
3.	TxDOT Statewide Average Bid Prices	It records the bid item and a price list from different projects TxDOT has undertaken.
4.	Local Suppliers and Subcontractors	Quotes obtained from material suppliers and subcontractor for utility work.

Table 5-1 List of other sources of utility cost information

Relevant cost information was found in these sources, however most of it was disorganized and in bits and pieces. So, a cost estimation spreadsheet model was prepared using the data available through above sources, to derive unit cost for different utility types. The process followed in development of the spreadsheet model and the cost data derived through it has been discussed in the following sub sections.

INTRODUCTION TO THE MODEL

As described earlier, the model was created to fill the gaps in the unit cost database for pipeline utilities for which limited agreement data was available. The pipeline utility types such as Gas, Water and Wastewater can be categorized into sub categories based upon the underground installation technique i.e. Open Trenching or Boring and Casing. This categorization is represented in the Figure 5-1.

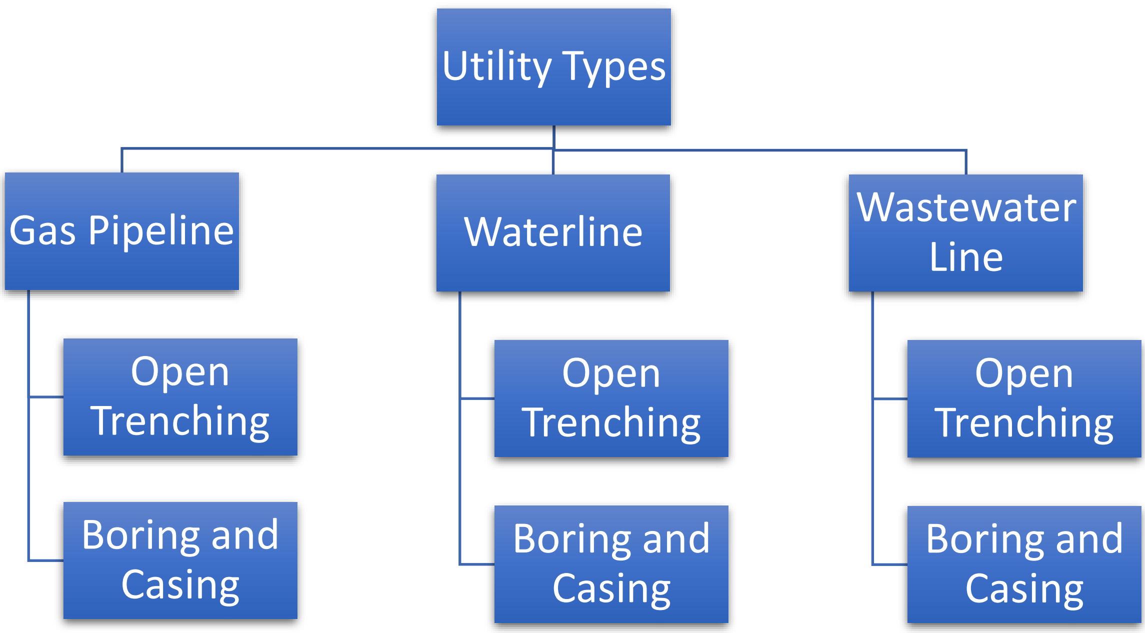

Figure 5-1 Sub categorization of Pipeline Utilities

For Electric Distribution and Communication utilities, finding costs for individual cost components was infeasible due to large number of cost components such as cables, splicing, poles, ducts, fittings etc. Hence, past agreements were considered as the best source for deriving unit cost. For pipeline utilities such as Gas, Water and Wastewater the total relocation cost was divided into several cost components which are discussed in detail in the following section.

UNIT COST COMPONENTS

Several agreements were studied and it was found that pipeline utility types i.e. Gas Pipeline, Waterline and Waste-Waterline, consisted of three major cost components which are listed in Table 5-2. The cost of these components was researched or derived for each required diameter size of pipe (Gas, Water or Wastewater) and summed up to arrive at the unit cost of relocation of a facility.

Unit Cost Components	
Sr. No	**Cost Component**
1	Pipe
2	Appurtenances Costs
3	Excavation Costs

Table 5-2 Unit Cost Components for pipeline utilities

WATERLINE

The unit cost for per feet relocation of waterline pipe was calculated by adding up the individual costs of cost components defined in previous section. The assumptions, criteria and method to derive the tabulated cost components is discussed below in detail.

Pipe Cost

RS Means was used as a source for estimation of cost of pipe. The assumptions made while deriving the cost of the pipe are given below -

(1) The average cost of the following two types of pipe material was considered.
- Ductile Iron – Class 50 water piping, cement lined with mechanical joint
- PVC – Pressure Pipe, Class 200, ASTM 2241, SDR 21 (for 4” to 8”) & AWWA C905, PR-100, DR 25 (for 16” to 24”)

(2) The cost of larger diameter pipe (30” & 36”) were not available in RS-Means. Hence, they were interpolated using the trend line observed using the cost of smaller diameter size pipes found in RS Means. The trend line for the pipe cost observed and the table containing the pipe cost data is shown in Figure 5-2 and Table 5-3.

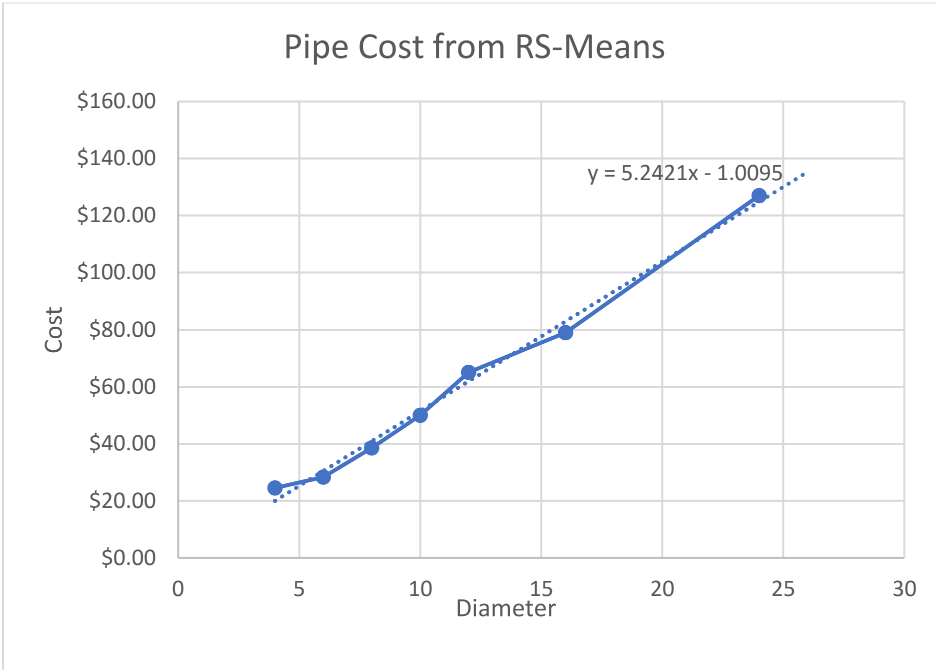

Figure 5-2 Interpolation of Waterline Pipe Cost

Diameter	Pipe Cost (RS Means)	Interpolated Costs
4”	$24.50	19.95
6”	$28.30	30.44
8”	$38.50	40.92
9”	NA	46.16
10”	$50.00	51.41
12”	$65.00	61.89
15”	NA	77.62
16”	$79.00	82.86
18”	NA	93.34
24”	$127.00	124.80
30” (Interpolated)	NA	156.25
36” (Interpolated)	NA	187.70

Table 5-3 Waterline Pipe Costs

Appurtenances Costs

Appurtenances includes items such as Fittings, Caps, Retainers, Gate Valves, Bends etc. Several utility agreements were studied to formulate a way to estimate the cost of these discrete items. It was found that the cost of these items per foot varied considerably depending upon the length of the pipe and other factors. So, after discussion with research team members and analyzing different agreements the following assumptions were made.

(1) The cost of Fittings, Caps, Retainers, Gate Valves, Bends etc. were taken as a suitable percentage of the cost of pipe.

(2) To incorporate the variability in the cost of these items three different percentages were used to arrive at the minimum, average and maximum cost for this component.

Percent of Cost of the pipe		
Minimum	Average	Maximum
20.00%	47.50%	75.00%

Table 5-4 Percentage factors for Fittings, Bends, Valves etc. cost

The following equations were used to derive the cost of the referred items -

(a)Minimum Cost of Fittings, Caps etc. = (Minimum Percentage Factor) x (Cost of pipe)

(b) Average Cost of Fittings, Caps etc. = (Average Percentage Factor) x (Cost of pipe)

(c)Maximum Cost of Fittings, Caps etc. = (Maximum Percentage Factor) x (Cost of pipe)

Trenching or Boring Costs

(A) Excavation and Filling Cost

Excavation and filling cost constitute a small part of the total cost of utility relocation and is in the range of \$0.50 to \$2.25 per foot. Therefore, to reduce the complexity in the estimation process, a conservative amount of \$2.00 per foot was considered as the cost of excavation and backfilling.

Also, it was observed in some utility agreements that the excavation and filling cost in case of open trench construction is not considered as a separate cost item. It is either included as a part of another major cost item or is neglected in comparison to them.

(B) Boring and Casing Cost

Through discussion with the individuals involved in the research, it was found that horizontal boring technique is the being used in most of the utility relocation projects. Since limited data was available in RS-Means related to the horizontal boring costs, several utility agreements were researched to find the boring and casing cost corresponding to different sizes of bores.

Table 5-5 shows the boring and casing costs per foot (including cost of carrier water pipeline) which were found through the agreements.

Boring Diameter	**Boring and Casing Cost ($) w/Carrier Pipe per foot**
3”	$52
6”	$78
10”	$124
12”	$135
15”	$156

Table 5-5 Boring and Casing Costs with carrier pipe cost

Using these costs, a trend line was plotted, and boring and casing cost (including carrier waterpipe) for other required boring diameters was interpolated. The trend line observed and the table of boring costs derived is shown in Figure 5-3 and Table 5-6.

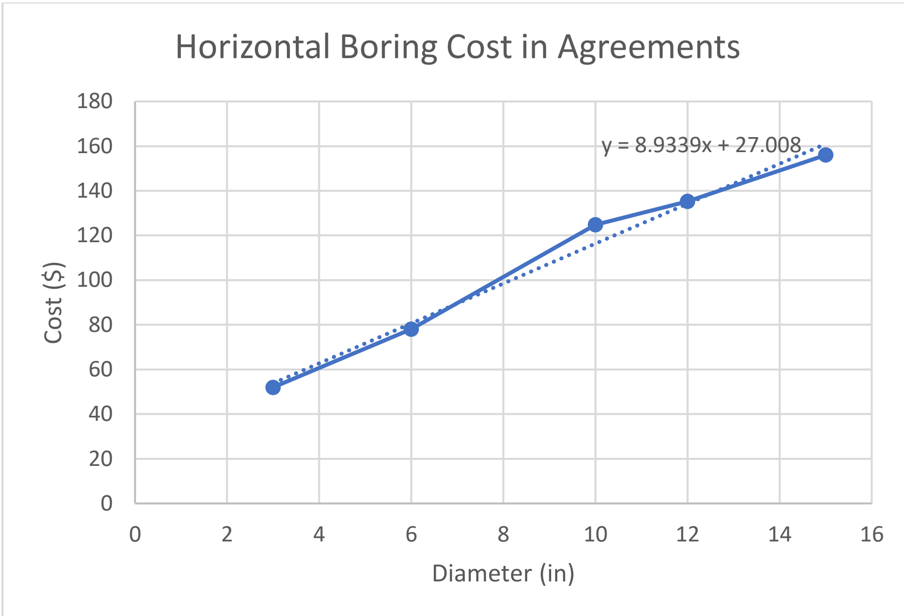

Figure 5-3 Interpolated Costs for Boring and Casing

Required Boring Diameters	**Interpolated Boring and Casing Cost ($) w/Carrier waterpipe Costs per foot**
3”	$53.80
6”	$80.61
9”	$107.41
12”	$134.21
15”	$161.01
18”	$187.81
24”	$241.42
36”	$348.62
45”	$429.03
54”	$509.43

Table 5-6 Interpolated Boring and Casing costs

Next step was to separate the cost of carrier waterpipe from the Boring and Casing cost. The cost of carrier pipe tabulated in Table 5-3 were subtracted from the cost of appropriate Boring and Casing (w/Carrier waterpipe) costs to derive the cost for Boring and Casing for different bore diameters.

An important consideration/assumption made while deriving these costs was that boring diameter was 1.5 times the diameter of carrier pipe. For example, for calculating the cost of Boring and Casing for Bore diameter of 6”, cost of carrier pipe of 4” (i.e. 6”/1.5) was separated out from the Boring and Casing w/ Carrier Pipe cost for 6” Bore diameter. The Boring and Casing costs derived for various diameters is given in Table 5-7.

Boring Diameters	**Interpolated Boring and Casing Cost ($) w/Carrier waterpipe Costs**	**Corresponding Carrier Pipe Diameter (Boring Diameter/1.5)**	**Carrier Pipe Cost**	**Boring and Casing Cost**
3”	$53.81	2”	$9.47	$44.34
6”	$80.61	4”	$19.95	$60.65
9”	$107.41	6”	$30.44	$76.97
12”	$134.21	8”	$40.92	$93.29
15”	$161.02	10”	$51.41	$109.61
18”	$187.82	12”	$61.89	$125.92
24”	$241.42	16”	$82.86	$158.56
36”	$348.63	24”	$124.80	$223.83
45”	$429.03	30”	$156.25	$272.78
54”	$509.44	36”	$187.70	$321.73

Table 5-7 Final Boring and Casing Costs calculated

GAS PIPELINE

Similar methodology was used to find the relocation costs of gas line facilities. All individual cost components were summed up to arrive at total cost of relocation.

Pipe Cost

RS Means was used as a source for estimation of cost of pipe. The following assumptions were made while selecting the pipe type and costs.

(1) Steel Pipe – Tar Coated and Wrapped, Schedule 40, Plain end was considered.

(2) Cost of all the required diameters was derived from RS-Means.

A table showing the cost of pipes of varying diameter is shown in Table 5-8.

Diameter	Pipe Cost (RS Means)
2”	$13.41
4”	$26.30
6”	$44.74
8”	$67.41
16”	$209.45
24”	$449.00

Table 5-8 Gas Steel Pipe Costs

Appurtenances costs

Same approach as described earlier for water lines was adopted to find the cost of fittings, caps, retainers, gate valves, bends etc.

Trenching or Boring Costs

(A) Excavation and Filling Cost

Same approach as described earlier for water lines was used to calculate excavation and filling costs as defined earlier in the report.

(B) Boring and Casing Cost

Same approach as described earlier for water lines was used as defined in earlier section.

WASTEWATER LINE

Pipe Cost

Pipe costs were derived from Bid Prices available at City of Austin website. The following assumptions were made while selecting the pipe material and costs.

(1) Wastewater SDR 26 PVC Pipe was considered.

(2) Costs for pipe diameters which were not available in the COA database, were interpolated.

(3) To adjust the interpolation the minimum cost was restricted at $15 per feet.

The interpolated costs and the trendline observed are shown the Figure 5-4 and Table 5-9.

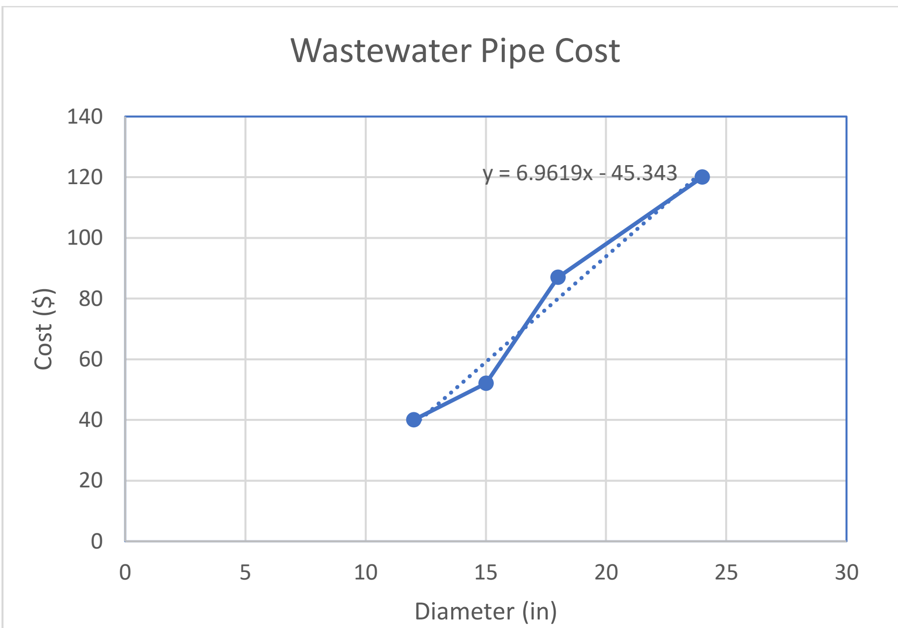

Figure 5-4 Trendline observed for Wastewater Pipe Cost

Wastewater Pipe Cost

Diameter (in)	Interpolated Cost ($)
4	$15.20
6	$16.30
8	$17.10
10	$24.28
12	$38.20
14	$52.12
16	$66.05
18	$79.97
24	$121.74
30	$163.51

Table 5-9 Wastewater Pipe Cost

Appurtenances costs

Same approach as described for water lines in earlier section was adopted to find the cost of fittings, caps, retainers, gate valves, bends etc.

Trenching or Boring Costs

A) Excavation and Filling Cost

Same approach was used as defined for water lines in previous section.

B) Boring and Casing Cost

Same approach was used as defined for water lines in previous section.

FINAL UNIT COST

The final step in the process was to sum all the unit cost components and add an overall percentage for Mobilization, Engineering and Management Costs to arrive at the final unit cost of utility relocation of a facility.

Summing up all cost components

As described earlier, three different values (minimum, average and maximum) were derived for cost of fittings, caps, gate valves, bends etc. for each diameter size of pipe. Thus, three different values (minimum, average and maximum) were found for final unit cost of each diameter size of utility based on varying cost of fittings, caps, gate valves etc. A screenshot of the estimation spreadsheet depicting the same is shown in the Figure 5-5.

4" Waterline --- Open Trenching											
Minimum				Average				Maximum			
Sr. No.	Item	Unit	Unit Cost	Sr. No.	Item	Unit	Unit Cost	Sr. No.	Item	Unit	Unit Cost
1	Pipe	LF	$24.54	1	Pipe	LF	$24.54	1	Pipe	LF	$24.54
2	Fittings,Caps,Retainers,Gate Valves,Bends, Thrust Retainer Kits, Tap Sleeve, Tees, Reducers etc.	LF	$4.91	2	Fittings,Caps,Retainers,Gate Valves,Bends, Thrust Retainer Kits, Tap Sleeve, Tees, Reducers etc.	LF	$11.66	2	Fittings,Caps,Retainers,Gate Valves,Bends, Thrust Retainer Kits, Tap Sleeve, Tees, Reducers etc.	LF	$18.41
3	Excavation and Backfill	LF	$2.00	3	Excavation and Backfill	LF	$2.00	3	Excavation and Backfill	LF	$2.00
	Total		**$31.45**		**Total**		**$38.20**		**Total**		**$44.95**

Figure 5-5 Sum of all cost components

Similar breakdown of the cost components for all Waterline, Wastewater line and Gas Pipeline facility types are provided in the excel spreadsheet model.

Mobilization, Engineering and Management Costs

Based upon the costs observed in the agreements studied, a conservative percentage of 20% was determined for Mobilization, Engineering and Management costs and was added to the total of all cost components to calculate the final unit cost of utility relocation.

RESULTS FROM THE SPREADSHEET COST MODEL

The final unit costs obtained are tabulated in this section along with the reference/comparison costs available from the 'Highway (CSJ) Cost Est' spreadsheet made available by the TxDOT Austin District. The comparison cost cells have been highlighted as green, orange or red to indicate the consistency of the comparison cost with the costs obtained through the study. Green highlighted cell indicates that comparison cost is within the range of maximum and minimum costs found in the study. Orange highlighted cell indicates that the comparison cost is within 20% of either the maximum or minimum of the costs found in the study. The red highlighted cell indicates that comparison cost is more than 20% off the range of either the maximum or minimum of the costs found in the study.

Waterline

A summary table listing the cost values for different water facility types derived using the cost estimation model juxtapose to the reference cost provided in the 'Highway (csj) Cost Est' spreadsheet was developed. Variance was also calculated showing the deviation of average cost from the comparison cost.

Waterline (OT)

Diameter	Min	Average	Max	Comparison	Variance
4"	$38	$46	$54	$42	-$4
6"	$43	$53	$62	$58	$5
8"	$58	$70	$83	$69	-$1
10"	$74	$91	$107	$90	-$1
12"	$96	$118	$139	$159	$41
16"	$116	$142	$169	$186	$44
24"	$186	$228	$271	$217	-$11
30"	$227	$279	$330	$286	$7
36"	$273	$335	$397	$344	$69

Table 5-10 Waterline (Open Trenching) Unit Cost Results

Waterline (w/B&C)

Diameter	Min	Average	Max	Comparison	Variance
4”	$108	$116	$124	$69	-$47
6”	$133	$142	$152	$101	-$41
8”	$167	$180	$193	$133	-$47
10”	$204	$220	$298	$164	-$56
12”	$245	$266	$288	$212	-$54
16”	$304	$330	$356	$265	-$65
24”	$453	$495	$537	$408	-$87
30”	$552	$603	$655	$519	-$84
36”	$656	$718	$780	$625	-$93

Table 5-11 Waterline (Boring and Casing) Unit Cost Results

It was observed from the above tables that most of the costs found in the study were consistent (green or orange) with the comparison costs available from the ‘Highway (csj) Cost Est’.

Gas Pipeline

A summary table listing the cost values for different gas facility types derived using the cost estimation model juxtapose to the reference cost provided in the ‘Highway (csj) Cost Est’ spreadsheet was developed.

Gas Pipeline (OT)

Diameter	Min	Average	Max	Comparison	Variance
2	$22	$27	$31	$96	$69
4	$41	$49	$58	$106	$57
6	$67	$82	$97	$112	$30
8	$100	$122	$144	$117	-$5
16	$305	$374	$443	$159	-$215
24	$649	$798	$946	$212	-$586

Table 5-12 Gas Pipeline (Open Trenching) Unit Cost Results

Gas Pipeline (w/B&C)

Diameter	Min	Average	Max	Comparison	Variance
2	$84	$89	$93	$170	$81
4	$135	$144	$152	$186	$42
6	$194	$209	$223	$191	-$18
8	$259	$281	$303	$207	-$74
16	$592	$661	$730	$255	-$406
24	$1,065	$1,214	$1,362	$371	-$843

Table 5-13 Gas Pipeline (Boring and Casing) Unit Cost Results

It was observed from the table above that for both cases i.e. Open Trenching and Boring & Casing, for smaller diameters such as 2" & 4" the reference cost was on the higher side when compared to the costs found using the model. Whereas for larger diameters such as 16" & 24" the reference cost was a lower estimate when compared to costs derived using the model. A possible reason behind this could be the assumption made regarding the schedule of gas pipeline. Schedule of a pipe is a measure of the thickness of the pipe. The cost estimation model considers a single schedule size i.e. schedule 40 for all diameter sizes. The cost data provided in the reference sheet might consider different schedule sizes for different diameters. However, since no data is available regarding the cost parameters and specifications of the reference cost, the abovementioned reasoning cannot be validated.

Wastewater Line

The summary table lists the cost values for different wastewater facility types derived using the cost estimation model juxtapose to the reference cost provided in the 'Highway (CSJ) Cost Est' spreadsheet

Wastewater line (OT)

Diameter	Min	Average	Max	Comparison	Variation
4	$25	$30	$35	$80	$50
6	$26	$32	$37	$85	$53
8	$28	$33	$39	$90	$57
10	$38	$46	$54	$101	$55
12	$58	$71	$83	$111	$40
14	$78	$95	$112	$122	$27
16	$101	$123	$146	$133	$10
18	$118	$144	$171	$148	$4
24	$177	$217	$257	$175	-$42
30	$238	$291	$345	$207	-$84

Table 5-14 Wastewater line (Open Trenching) Unit Cost Results

Wastewater line (w/B&C)

Diameter	Min	Average	Max	Comparison	Variance
4	$95	$100	$105	$117	$17
6	$116	$122	$127	$143	$21
8	$137	$143	$148	$164	$21
10	$167	$175	$183	$196	$21
12	$207	$219	$232	$228	$9
14	$246	$263	$280	$254	-$9
16	$289	$311	$334	$286	-$25
18	$326	$352	$378	$318	-$34
24	$443	$483	$523	$408	-$75
30	$563	$616	$670	$498	-$118

Table 5-15Wastewater line (Boring and Casing) Unit Cost Results

It was observed from the above tables that most of the costs found in the study were consistent (green or orange) with the comparison costs available from the ‘Highway (csj) Cost Est’.

Chapter 6 Results and Conclusion

The two forms of data collected discussed in Chapter 4 and Chapter 5 were coalesced together to generate a master cost database spreadsheet. This database lists the unit costs which were derived from the good quality utility agreements alongside the costs which were derived using the cost spreadsheet model developed using different item level costs gathered from RS Means, City of Austin and TxDOT average price database. This spreadsheet model is attached as an appendix to this report.

STRUCTURE OF THE SPREADSHEET

The spreadsheet contains a set of information about a utility type. This information is organized in multiple columns in the spreadsheet. The description about each one of them is given below-

(1) Facility Specifications – This contains general information about the utility such as type of facility, the size of pipe/conduit, Overhead/Underground, Type of underground boring technique used, in case of underground utility.

(2) Cost from Historical Data Sources– This contains the minimum, average and maximum costs which were derived from the model that was developed using the cost information from RS-Means and other historical cost data sources including TxDOT Average Bid Prices, and City of Austin Database. Although other sources of information were also used while deriving this information, but a major chunk of information was taken from RS-Means.

(3) Agreement Cost – It contains the cost information that was derived from cost estimates provided in the utility agreements. Some of the utility types were included in more than one agreement so multiple costs have been populated for such utilities, which provides a cost range in which the unit cost can lie. The agreement cost is also supported by a reliability rating which indicates the quality of the agreement. The quality of an agreement is rated in terms of well-defined scope, clear quantity description, comprehensiveness of the cost items etc. A star “*” notation is used against the unit cost which was derived from a good quality agreement.

(4) Reference Cost – This reference cost is listed by taking the unit cost rates from the spreadsheet which was provided by the TxDOT team to be used as a basis of comparison for the results obtained from the agreement analysis and other cost information sources.

(5) Agreement Details – Another part of the spreadsheet provides the details of the agreements which were researched to derive the agreement unit costs. Details specifying the type of the facility found in the agreement are listed along with the agreement number. It also includes detailed comments on the scope of work, inclusions and exclusions in the costs, the assumptions made while deriving the unit costs and challenges faced if any during the process.

Screenshots from the final cost spreadsheet is shown in Figure 6-1.

Unit Cost Estimates for Utility Relocation

Facility Specifications					RS Means Cost			Agreement Cost		Reference Cost
Sr. No.	Facility Type	Size	OH/UG	UG Technique (If UG)	Min	Avg	Max	Unit Cost	Reliability	Unit Cost
1	Gas	2″	UG	Open Trenching	$22	$26	$38	$59	*	$95
2	Gas	2″	UG	Boring and Casing	$83	$89	$93			$170
3	Gas	4″	UG	Open Trenching	$40	$49	$51	$95	*	$106
4	Gas	4″	UG	Boring and Casing	$134	$144	$152	$263 $254	* 	$186
5	Gas	6″	UG	Open Trenching	$66	$81	$96	$118 $130	* 	$111
6	Gas	6″	UG	Boring and Casing	$193	$208	$222	$168	*	$191
7	Gas	8″	UG	Open Trenching	$100	$121	$143			$117
8	Gas	8″	UG	Boring and Casing	$258	$280	$302	$442		$207
9	Gas	16″	UG	Open Trenching	$304	$372	$442			$159

Figure 6-1 The structure of Final Cost Spreadsheet

Facility Specifications					Agreement Details	Comments
Sr. No.	Facility Type	Size	OH/UG	UG Technique (If UG)	Agreement No.	
1	Gas	2″	UG	Open Trenching	U 111	The agreement contains relocation work of 2", 4" & 6" gas pipe. The costs for each utility is separate. Both Total Cost and Total feet of work are directly available in the agreement in Capital Job Order Sheet, also a part of Appendix B - Agreement Scan
2	Gas	4″	UG	Open Trenching	U 111	
3	Gas	4″	UG	Boring and Casing	U 10951	SOW- Lowering 1200 feet of 4" Gas Pipeline. Cost includes - 1. Labor 2. Material 3. Engineering and Design 4. Tests, Inspection, Services etc. Total cost and total feet are clearly mentioned in the agreement Costs for ROW, Pipe Removal have been deducted from actual agreement cost.
					U 12557	Installation of 3.5" Steel & 4" Poly pipe 200' and 400' respectively Cost includes - 1. Material 2. Construction 3. Engineering and Services 4. Contract Expense 5. Overhead Since the difference in diameter was not much, hence both types of pipe were considered as one type.

Figure 6-2 Details of the Agreements along with comments

These unit costs obtained can be directly fed into a cost estimating system which can then be used to generate cost estimation reports by inputting the quantity in linear feet of work and selecting the type of facility being relocated.

SCOPE FOR IMPROVEMENT

Since there are certain gaps in the spreadsheet, due to limited availability of useful agreements, there is a scope for future improvement in the database. As more agreements are executed between TxDOT and utility companies, the details of the cost agreement and the cost information can be updated in the final cost spreadsheet, which will help in filling up those gaps and also provide a better basis of comparison for the costs already listed. Also, the format of utility agreements should be modified to include all the relevant details which are required to calculate the unit cost of work, thus making the process of updating the database smoother. Further, an effort should be made to digitize the agreements stored at TxDOT data archives, so that the process of data collection and analysis is smoother and more efficient in further studies.

CONCLUSION

This section of the chapter discusses the conclusions derived from completion of research objectives and recommendation for future works:

1) Utility adjustment is a crucial step to effective project delivery and accurate cost estimates help in ensuring that the DOTs have enough flow of funds to reimburse for the relocation process. Thus, preventing any delay in the adjustment process and further avoiding any time impacts on the overall delivery of the highway project.
2) The DOTs should act towards standardizing the cost estimates that are submitted by the utility companies, so that the cost information contained in them is easy to analyze, compare and record, for future references. This would also make the process of further populating the unit cost database more easy and efficient.
3) Although the concept behind deriving unit cost data through utility agreements is simple, the overall process is complicated by several physical and technical limiting factors discussed in Chapter-4. While developing the research plans for future studies, they should be kept in mind.
4) Cost related information regarding utility relocation is available from different other sources, however the inclusions and exclusions of these cost items are rarely defined which creates a need to make certain assumptions about these costs and the results derived are also subject to the validity of these assumptions.
5) This study is one of the few where actual cost data from past utility agreements was studied and analyzed to derive unit cost rates. It lays the foundation for upcoming work to be done in this field and also indicates the challenges that need to be overcome.

Appendix

Final Unit Cost Dabase

Unit Cost Estimates for Utility Relocation

Facility Specifications					RS Means Cost			Agreement Cost		Reference Cost	Agreement Details
Sr. No.	Facility Type	Size	OH/UG	UG Technique (If UG)	Min	Avg	Max	Unit Cost	Reliability	Unit Cost	Agreement No.
1	Gas	2″	UG	Open Trenching	$22	$26	$38	$59	*	$95	U 111
2	Gas	2″	UG	Boring and Casing	$83	$89	$93			$170	
3	Gas	4″	UG	Open Trenching	$40	$49	$51	$95	*	$106	U 111
4	Gas	4″	UG	Boring and Casing	$134	$144	$152	$263 $254	*	$186	U 10951 U 12557
5	Gas	6″	UG	Open Trenching	$66	$81	$96	$118 $130	*	$111	U 111 U 11075
6	Gas	6″	UG	Boring and Casing	$193	$208	$222	$168	*	$191	U 10007
7	Gas	8″	UG	Open Trenching	$100	$121	$143			$117	
8	Gas	8″	UG	Boring and Casing	$258	$280	$302	$442		$207	U 3755
9	Gas	16″	UG	Open Trenching	$304	$372	$442			$159	
10	Gas	16″	UG	Boring and Casing	$591	$660	$729			$254	
11	Gas	24″	UG	Open Trenching	$648	$797	$945			$212	
12	Gas	24″	UG	Boring and Casing	$1,064	$1,213	$1,361			$371	
13	Waterline	4″	UG	Open Trenching	$38	$46	$54			$42	
14	Waterline	4″	UG	Boring and Casing	$108	$116	$124			$69	
15	Waterline	6″	UG	Open Trenching	$43	$53	$62			$58	
16	Waterline	6″	UG	Boring and Casing	$133	$143	$152	$104	*	$101	U 11773
17	Waterline	8″	UG	Open Trenching	$58	$71	$83	$30		$69	U 11721
18	Waterline	8″	UG	Boring and Casing	$167	$180	$193	$170 $123	 *	$133	U 11721 U 11773
19	Waterline	10″	UG	Open Trenching	$74	$91	$107	$35		$90	U 11721
20	Waterline	10″	UG	Boring and Casing	$204	$220	$298			$164	
21	Waterline	12″	UG	Open Trenching	$96	$118	$139	$279		$159	U 10306
22	Waterline	12″	UG	Boring and Casing	$245	$266	$288	$207 $303	*	$212	U 12182 U 12574
23	Waterline	16″	UG	Open Trenching	$116	$143	$169	$393		$186	U 10306
24	Waterline	16″	UG	Boring and Casing	$304	$330	$356			$265	
25	Waterline	24″	UG	Open Trenching	$186	$228	$271			$217	
26	Waterline	24″	UG	Boring and Casing	$453	$494	$537			$408	
27	Waterline	30″	UG	Open Trenching	$227	$278	$330			$286	
28	Waterline	30″	UG	Boring and Casing	$552	$604	$655			$519	
29	Waterline	36″	UG	Open Trenching	$273	$335	$397			$345	
30	Waterline	36″	UG	Boring and Casing	$656	$719	$780			$625	
31	Wastewater	4″	UG	Open Trenching	$24	$29	$34			$80	
32	Wastewater	4″	UG	Boring and Casing	$94	$100	$104			$117	
33	Wastewater	6″	UG	Open Trenching	$26	$31	$36			$85	
34	Wastewater	6″	UG	Boring and Casing	$115	$121	$126			$143	
35	Wastewater	8″	UG	Open Trenching	$27	$32	$37	$59		$90	U 11836
36	Wastewater	8″	UG	Boring and Casing	$136	$142	$147			$164	
37	Wastewater	10″	UG	Open Trenching	$37	$44	$53	$82	*	$101	U 11773
38	Wastewater	10″	UG	Boring and Casing	$166	$174	$182			$196	
39	Wastewater	12″	UG	Open Trenching	$57	$70	$83			$111	
40	Wastewater	12″	UG	Boring and Casing	$206	$218	$231			$228	
41	Wastewater	14″	UG	Open Trenching	$77	$94	$112	$113	*	$122	

Unit Cost Estimates for Utility Relocation

Facility Specifications					RS Means Cost			Agreement Cost		Reference Cost	Agreement Details
Sr. No.	Facility Type	Size	OH/UG	UG Technique (If UG)	Min	Avg	Max	Unit Cost	Reliability	Unit Cost	Agreement No.
42	Wastewater	14″	UG	Boring and Casing	$145	$262	$279			$254	
43	Wastewater	16″	UG	Open Trenching	$100	$122	$145			$133	
44	Wastewater	16″	UG	Boring and Casing	$288	$310	$333			$286	
45	Wastewater	18″	UG	Open Trenching	$117	$144	$170			$148	
46	Wastewater	18″	UG	Boring and Casing	$325	$350	$377			$318	
47	Wastewater	24″	UG	Open Trenching	$176	$216	$256			$175	
48	Wastewater	24″	UG	Boring and Casing	$442	$482	$522			$408	
49	Wastewater	30″	UG	Open Trenching	$237	$290	$344			$207	
50	Wastewater	30″	UG	Boring and Casing	$568	$616	$669			$498	
51	Electric Distribution	N/A	OH	N/A				$42		$64	U 11727
								$67	*		U 11467
								$65	*		U 11906
								$62	*		U 12398
								$62	*		U 12603
								$28			U 10288
								$29			U 12579
								$94	*		U 13755
								$87	*		U 11841
52	Electric Distribution	N/A	UG	Open Trenching				$46		$186	U 12579
53	Electric Distribution	N/A	UG	Boring and Casing				$341	*	$371	U 12579
54	Communication	N/A	OH	N/A				$61	*	$53	U 14551
								$40	*		U 0013
55	Communication	Small	UG	Open Trenching				$38		Not known	U 13859
								$52		Not known	U 11835
56	Communication	Small	UG	Boring and Casing				$126		$159	U 14550
								$171			U 14554
57	Communication	Large	UG	Open Trenching							
58	Communication	Large	UG	Boring and Casing				$230		Not known	U 14546
								$254	*	$265	U 14551
								$265	*	$212	U 11199

Notes-

1 All the costs have been adjusted to account for inflation upto the year 2017

2 * indiacates that the unit cost derived is reliable and the agreement quality is good for analysis.

Agreement Analysis

Detailed Comments on Utility Agreements

Facility Specifications					Agreement Details	Comments
Sr. No.	Facility Type	Size	OH/UG	UG Technique (If UG)	Agreement No.	
1	Gas	2″	UG	Open Trenching	U 111	The agreement contains relocation work of 2", 4" & 6" gas pipe. The costs for each utility is separate. Both Total Cost and Total feet of work are directly available in the agreement in Capital Job Order Sheet, also a part of Appendix B - Agreement Scan
2	Gas	4″	UG	Open Trenching	U 111	
3	Gas	4″	UG	Boring and Casing	U 10951	SOW- Lowering 1200 feet of 4" Gas Pipeline. Cost includes - 1. Labor 2. Material 3. Engineering and Design 4. Tests, Inspection, Services etc. Total cost and total feet are clearly mentioned in the agreement Costs for ROW, Pipe Removal have been deducted from actual agreement cost.
					U 12557	Installation of 3.5" Steel & 4" Poly pipe 200' and 400' respectively Cost includes - 1. Material 2. Construction 3. Engineering and Services 4. Contract Expense 5. Overhead Since the difference in diameter was not much, hence both types of pipe were considered as one type.
4	Gas	6″	UG	Open Trenching	U 111	Mentioned above
					U 11075	Relocation of 6" poly gaspipe. Cost Includes - 1. Material 2. Construction 3. Engineering and Design 4. Overhead Agreement Consisted of both Open Tench and Boring and Casing work. Cost of Boring & Casing was assumed based on a different agreement(10007) and cost of Open trenching was found.

Detailed Comments on Utility Agreements

Facility Specifications					Agreement Details	Comments
Sr. No.	Facility Type	Size	OH/UG	UG Technique (If UG)	Agreement No.	
5	Gas	6"	UG	Boring and Casing	U 10007	Work includes relocation of 6" gas pipe. The cost includes materials, labor, Overheads. The cost is directly available in the agreement and the total feet is taken as the length of 6" pipe.
6	Gas	8"	UG	Boring and Casing	U 3755	Work Includes installing a new 8" gas pipe using directional drilling. Most TxDOT projects use Horizontal boring hence the agreement cost is on the higher side. Total Cost excluding contingency has been taken from the agreement and total feet have been taken as the feet of directional drilling done.
7	Waterline	6"	UG	Boring and Casing	U 11773	Only Construction Costs are included. So an additional 15% is added to account for overheads. The total cost were modified to come up with cost for Boring and Casing as only some portion of the work in original agreement consisted of Boring and Casing work.
8	Waterline	8"	UG	Open Trenching	U 11721	Work includes - Furnishing and Install 8" water pipeline. Work consisted of both open trenching and boring and casing, so costs were seperated by making appropriate calculations. Agreement costs consisted of only contruction costs so costs have been modified to account for mobilisation, Engineering and Management.
9	Waterline	8"	UG	Boring and Casing	U 11721	
					U 11773	Mentioned above
10	Waterline	10"	UG	Open Trenching	U 11721	Work includes - Furnishing and Install 10" water pipeline. Agreement costs consisted of only contruction costs so costs have been modified to account for mobilisation, Engineering and Management.
11	Waterline	12"	UG	Open Trenching	U 10306	Work includes addition of 16 " & 12 " DI water pipeline. Cost components of both works had to be separated. Unit Costs are high because the type of pipe is DI pipe. Agreement costs consisted of only contruction costs so costs have been modified to account for mobilisation, Engineering and Management.

Detailed Comments on Utility Agreements

Facility Specifications					Agreement Details	Comments
Sr. No.	Facility Type	Size	OH/UG	UG Technique (If UG)	Agreement No.	
12	Waterline	12"	UG	Boring and Casing	U 12182	Work Includes - Replacement and extension of 12" waterline using trenching & casing and Boring & case work. Cost in the agreement was modified to calculate cost for only Boring and Casing and for trenching and casing
					U 12574	The work includes relocation of 12" pipeline. Total linear feet is mentioned in the description of work and total cost is also available. The type of UG technique is not exactly specified. Encasement is mentioned. Looking at the cost Boring and Casing is assumed.
13	Waterline	16"	UG	Open Trenching	U 10306	Mentioned above
14	Wastewater	8"	UG	Open Trenching	U 11836	Work includes placing 50 ft long 8" pipe and raising manholes. The SOW of work is small and not constitute complete relocation. The manhole is existing and need not be constructed. Only Construction Costs are included. So an additional 15% is added to account for overheads.
15	Wastewater	10"	UG	Open Trenching	U 11773	Work Includes replacing 10" gravity line with 15" gravity line. So cost of both are available in the agreement Only Construction Costs are included. So an additional 15% is added to account for overheads.Comparison cost of 14" was used to compare the cost of 15" Open trenching type of work is assumed because no encasement is specified in costs or work description
16	Wastewater	14"	UG	Open Trenching		

Detailed Comments on Utility Agreements

Facility Specifications					Agreement Details	Comments
Sr. No.	Facility Type	Size	OH/UG	UG Technique (If UG)	Agreement No.	
17	Electric Distribution	N/A	OH	N/A	U 11906	Very Good Quality Agreement. SOW- Relocation of Electric line for 3.53 miles in rural area (Georgetown). Exact length of project was possible to determine by comparing Agreement map with google map. Cost Components - 1. Material (Install and Removal) 2. Labor 3. Overhead
					U 12398	Very Good Quality Agreement. SOW- Relocation of Electric line for 13,000 ft (2.46 Miles) in rural area (Georgetown). Exact length of project was given in the agreement. Also compared with google map. Cost Components - 1. Material (Install and Removal) 2. Labor 3. Overhead
					U 12603	Very Good Quality Agreement. SOW- Relocation of Electric line for 3142 ft in rural area (Georgetown). Exact length of project was given in the agreement. Also compared with google map. Cost Components - 1. Material (Install and Removal) 2. Labor 3. Overhead
					U 10288	SOW- Relocation of OH electric line Cost Components - 1. Labor 2. Material 3. Overhead 4. O&M 5. ROW Services and Transportation
					U 12579	SOW- Relocation of OH electric line Cost Components - 1. Labor 2. Material 3. Overhead Quantity taken as length of Primary Cable
					U 13755	Very Good Quality Agreement. SOW- Relocation of 12 wood poles and all ancillary related equipment. Basically Relocation of Electric line for 607 feet of line.
					U 11841	Good Quality agreement. Total linear feet are mentioned in the scope of work and total costs are indicated. Unit cost might be on the higher side because of large no. of poles and other appurtenances.

Detailed Comments on Utility Agreements

Facility Specifications					Agreement Details	Comments
Sr. No.	Facility Type	Size	OH/UG	UG Technique (If UG)	Agreement No.	
18	Electric Distribution	N/A	UG	Open Trenching	U 12579	SOW- Relocation of UG electric line with 4-4" PVC conduit Schedule 40 with open trenching Cost Components - 1. Labor 2. Material Total cost was given for UG Open Trenching and Boring and Cost. Cost had to be modified to get separate costs.
19	Electric Distribution	N/A	UG	Boring and Casing	U 12579	SOW- Relocation of UG electric line with 4-4" PVC conduit Schedule 40 using 16" Steel Encasement Cost Components - 1. Labor 2. Material Total cost was given for UG Open Trenching and Boring and Cost. Cost had to be modified to get separate costs.
20	Communication	N/A	OH	N/A	U 14551	This unit cost is directly available in the estimate. Works include 1 Overlashing, Relashing/Delashing 2. Splicing. Major Component 1. Cost is of Splicing
					U 0013	Assuming length of strand is length of project Comments- Relocation of 13,342ft of arieal 48 count fibre to new joint trench conduit bank and poles The fiber length is really large of the order 13,342ft. Pull out 108ct fiber Pull out 166ct fiber Lash 108ct fiber
21	Communication	Small	UG	Open Trenching	U 13859	Work Includes 1. Relocation of UG communication cable. 2777 feet. Includes UG lateral as well as crossing. All work is directional bore. However it is of small dia possibly. Concerns- Cost of Directional Bore is very low.
					U 11835	The costs and total linear feet are directly available in the agreement. The agreement also contain some boring and casing work so the costs were modified to separate out the cost of bore and casing.
22	Communication	Small	UG	Boring and Casing	U 14550	Same location and Project as Agreement 14546. Relocating the OH cable at oltorf to underground duct system
					U 14554	Work Includes- 1. Relocating Existing OH cable at Oltorf to an underground duct system.
23	Communication	Large	UG	Boring and Casing	U 14546	Work Includes- 1. Relocating Existing OH cable at Oltorf to an underground duct system.
					U 14551	This unit cost is directly available in the estimate. Work includes 1. Make Ready, Electronics, Pulling out cable through conduits, Material purchase, Cost of underground duct. Major Cost Components include- 1. cost component is for material. 2. Other cost components are Make Ready, Electronics. 3. Cost of making underground duct
					U 11199	Good Agreement. Qty and Cost easily available. The length of the project is large so the cost might be on the lower side.

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